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NEST-SITE AND AERIAL MEETING POINT SELECTION BY COMMON BUZZARDS (*BUTEO BUTEO*) IN CENTRAL ITALY

MARINA CERASOLI
Stazione Romana Osservazione e Protezione Uccelli, c/o Oasi Naturale WWF "Bosco di Palo"— Via Palo Laziale, 2,00055 Ladispoli (Roma), Italy

VINCENZO PENTERIANI
Laboratoire d'Ecologie, Université de Bourgogne, B.P. 138—21004 Dijon Cedex, France

ABSTRACT.—A nesting population of common buzzards (*Buteo buteo*) was studied in a mountainous area of central Italy from 1988–92. Nesting density averaged 19.74 pairs/100 km^2, and the average minimum distance between pairs was 1.4 km (SD = 0.432). Mean number of young fledged/successful nest was 1.78 for all years combined. Of nests examined, a significantly (P = 0.001) larger proportion were on slopes facing to the northeast (73.3%), most were on the mid-portions of slopes (60%), and were built at the intersections between tree branches and tree trunks (86.6%). Other factors including elevation, the angle between tree trunks and branches, tree height, tree crown volume, the distance of nests from a forest edge, the distance of the nest from areas of timber harvesting, and the average trunk spacing were also important variables in terms of nest placement. The distance of aerial meeting sites (areas where a group of at least three buzzards regularly soared, tumbled together, and chased each other) from neighboring nest sites and maximum slope were also important factors in the choice of these gathering points.

KEY WORDS: *nest-site selection; buzzard;* Buteo buteo; *reproduction; aerial meeting points; central Italy.*

Sitios de nidificación y selección de puntos de reunión aérea por *Buteo buteo* en Italia central

RESUMEN.—Una población nidificante de *Buteo buteo,* fue estudiada en un área montañosa de Italia central, desde 1988 a 1992. La densidad promedio de nidificación fue de 19.74 parejas/100 km^2, la distancia mínima promedio entre parejas fue de 1.4 km (DS = 0.432). El número medio de juveniles volantones/nido exitoso fue 1.78 para todos los años combinados. De los nidos examinados, una significativa proporción (P = 0.001) estaba sobre laderas de exposición noreste (73.3%), la mayoría estaba sobre la porción media de las laderas (60%) y fueron construidos en la intersección de ramas y troncos de árboles (86.6%). Otros factores que incluyeron elevación, ángulo entre ramas y troncos, altura del árbol, volumen de cosecha arbórea, distancia de los nidos al borde del bosque, distancia del nido a áreas de cosecha y el espacio promedio entre troncos, fueron importantes variables respecto a la ubicación del nido. La distancia de sitios aéreos de reunión (áreas donde un grupo de al menos tres individuos regularmente remontaban el vuelo, caían juntos y se perseguían unos a otros) a sitios de nidificación vecinos y máxima inclinación también eran factores importantes en la elección de estos puntos de reunión.

[Traducción de Ivan Lazo]

Studies on habitat use by birds show that they nest in those portions of the available natural environment which best suit their primary living requirements (Hilden 1965, Morse 1980, Cody 1985). Common buzzards (*Buteo buteo*) have been the focus of numerous and diversified studies, conducted in most of their range (Mebs 1964, Tubbs 1974, Rockenbauch 1975, Weir & Picozzi 1975, 1983, Picozzi & Weir 1976, Arce Velasco 1987); however, few data are available on their selection of nesting habitat (Kostrzewa 1987, Jedrzejewski et al. 1988, Kostrzewa & Kostrzewa 1988, Hubert 1993). This study was designed to characterize breeding density, reproductive success, and nest-site selection in a common buzzard population in a mountainous area. In addition, we sought to provide data on the selection and use of aerial meeting sites of buzzards (Tubbs 1974).

STUDY AREA

The study was conducted in a mountainous area measuring 400 km^2 between the Latium and Abruzzo regions of central Italy. Elevation of the area ranged from 508–1820 m. The landscape consisted of a mosaic of habitat types including forests, pastures, clearings, and piedmont crop areas. Forested areas were the most common cover type covering approximately 35.5% of the total area (I.S.T.A.T. 1991). Dominant tree species were *Castanea sativa, Quercus cerris, Q. pubescens, Pinus nigra,* and *Fagus sylvatica.* Most of the forested area was being used as coppice.

METHODS

We mapped forested areas using 1:25 000 scale maps and 1:10 000 scale aerial photos. Because common buzzards are found in a variety of habitats (Tubbs 1974, Cramp and Simmons 1980), all forested areas were surveyed for breeding pairs. We located occupied nesting areas by observing territorial flights, nuptial displays, nest building during the early stages of the breeding period (February–March), and prey deliveries to nests during the nestling period (June). We also used recorded playbacks of common buzzard calls during March, April, June, and October (Cerasoli and Penteriani 1992) to locate occupied nesting areas.

To assess reproductive success, we observed occupied nests from fledging until the young left the nest area (buzzard fledging period: 48–62 d, Cramp and Simmons 1980), and production was calculated as the mean number of fledgings/successful nest. To estimate nesting density, we used nearest neighbor distance (Newton et al. 1977).

Nest-site characteristics were analyzed on two levels. Level 1 analysis assessed features of nest trees and the nests themselves and Level 2 assessed habitat features surrounding the nest area (Table 1). Level 1 features were measured using a tree caliper, metric tape and compass.

Level 2 analysis used circular, nest-site plots with 30 m radii centered on nest trees (James and Shugart 1970, Reynolds et al. 1982, Titus & Mosher 1987, Jedrzejewski et al. 1988). Features of trees in plots were sampled using four, 30 m transects radiating from the nest tree at right angles to each other and following the four cardinal compass directions. Trees intercepted by the lines were measured using the line intercept method (Mueller-Dombois & Ellenberg 1974, Burnham et al. 1980, Bonham 1989). To identify possible habitat selection, we used a point-centered-quarter method (Mueller-Dombois & Ellenberg 1974, Bonham 1989) consisting of four plots established in each of the cardinal compass directions, 60 m from nest trees. These four plots were 60 m in diameter and four, 30 m transects radiated from the center of each plot in each of the cardinal compass directions. Canopy cover was measured along the four transect lines in each plot by estimating percentage of sky not obstructed by vegetation in black & white photos taken with a camera placed horizontally on a tripod and fitted with a 28 mm, f.3.5 lens. Nest-site characteristics were measured at a total of 15 occupied nests for Level 1 analysis, and at 13 occupied nests for Level 2 analysis.

We also measured habitat characteristics within a 0.5 km radius of eight aerial "rendezvous" sites (areas where a group of at least three common buzzards were regularly seen soaring, tumbling together and chasing each other, Tubbs 1974) to determine if the selection of these meeting sites was dependent on neighboring nest-site location and/or topographic features facilitating flight and minimizing energy requirements (Cody 1985). In this case, we used the point-centered-quarter method with four, 1-km diameter sample plots tangent to the rendezvous site and centered on the cardinal compass directions Percentage slope was calculated inside the plots and along slopes using the number of contour lines on topographic maps of the area. Using this method, maximum percentage slopes had the greatest number of contour lines and minimum percentage slopes had the fewest contour lines. By definition, rendezvous sites had to contain at least three common buzzards. The number of additional common buzzards at a rendezvous site was treated as the dependent variable in a multiple regression model. Independent variables were: (1) distance of the plot center from the nearest nest and (2) percent slope at the center of the plot.

Data were not in consistent units of measurement so we converted them to nondimensional index numbers. Qualitative variables, such as tree species and slope exposure were also transformed into indexes. We used (1) principal component analysis (PCA) to scale down the number of variables; (2) cluster analysis and analysis of variance (ANOVA) to test for nest-habitat selection; (3) chi-square tests to examine the distribution of nests relative to slope position and exposure; (4) chi-square and Mann-Whitney tests to compare characteristics of common buzzard nest sites and sample plots, and rendezvous sites and sample plots; and (5) multiple linear regression for characterization of rendezvous sites (Sokal and Rohlf 1981).

RESULTS

We found 15 pairs of breeding common buzzards in the 91.18 km^2 study area, for a density of 19.74 pairs/100 km^2. Minimum distance between the pairs averaged 1.4 km (SD = 0.43, range = 0.85–1.82). Egg-laying took place during the second week of April and fledging occurred in the first half of June. In only one case were eggs laid during the third week of April. Annual productivity of breeding pairs was 1.78 fledgings/successful pair (SD = 0.16, range = 1.62–2.00).

Common buzzards nested in a diversity of trees. Of 15 occupied nests, five (33%) were in *Castanea sativa* trees, three (20%) in *P. nigra* trees, two (13%) in *Q. cerris* trees, and one each (6.7%) was in a *Picea excelsa, Ostrya carpinifolia, F. sylvatica, Q. pubescens,* and *Populus* spp. tree. Eleven (73.3%) of the nest trees were on slopes that faced northeast and they were on the mid-portions of slopes. Thirteen nests were situated at the intersection between a tree branch and the trunk, and the remaining two nests were on lateral branches. Seven of the 24 variables measured at nests were significantly different from the same variables at measured sample plots: elevation ($F = 2.82$; $P =$

Table 1. Sample means and standard deviations of characteristics of nest-site and sample plots for common buzzards in central Italy.

	NEST SITES (RANGE)	CONTROL PLOTS (RANGE)	TEST STATISTIC
Level 1 Analysis (N = 15)			
Tree DBH (cm)	27.77 ± 7.27 (18–42)	—	χ^2 = 22.82
Tree height (m)	17.58 ± 2.96 (14–25)	—	χ^2 = 21.35
Nest height (m)	12.7 ± 2.77 (8.5–15.5)	—	χ^2 = 7.26
Relative height of nest in tree (%)	72.77 ± 1 (52.5–91.4)	—	χ^2 = 30.32*
Relative height of nest in crown (%)	48.85 ± 25.58 (5.88–92)	—	χ^2 = 160.96***
Number of branches supporting nest	3.92 ± 1.5 (2–7)	—	χ^2 = 3.03
Distance to nearest timber harvest (m)	40.28 ± 23.08 (4–71)	5.74 ± 21.76 (0–141)	U = 240, z = −1.4
Distance to nearest forest trail (m)	28.23 ± 19.4 (2–74)	42.5 ± 26.46 (0–98)	U = 433, z = −0.93
Distance to nearest water (m)	93.8 ± 59.77 (42–203)	102 ± 51.39 (6–250)	U = 302, z = −0.15
Distance to nearest woodland edge (m)	67.59 ± 48.41 (4–120)	72.4 ± 24.75 (0–182)	U = 273, z = −0.61
Level 2 Analysis (N = 13)			
Elevation (m)	927.33 ± 122.88 (770–1230)	989.3 ± 142.64 (750–1250)	U = 333, z = −0.01
Tree dbh (cm)	11.94 ± 10.42 (2–33)	8.92 ± 6.76 (2–90)	U = 340,** z = −3.36
Tree height (m)	10.74 ± 3.04 (3.5–25)	7.58 ± 3.56 (3.1–18)	U = 211,** z = −3.37
Height of trunk without branches (m)	5.15 ± 2.25 (1.1–11)	2.52 ± 1.47 (1.1–8.63)	U = 163, z = −1.31
Number branches in tree	21.55 ± 9.02 (14–55)	10.8 ± 9.69 (8–55)	U = 511,* z = −3.26
Angle between trunk and branches (°)	64.08 ± 7.74 (50–90)	37.6 ± 16.97 (30–90)	U = 169, z = −1.63
Tree crown volume (m^3)	170.02 ± 68.51 (29.44–463)	42.59 ± 37.26 (1.07–278.56)	U = 46,*** z = −4.04
Trunk spacing (m)	2.38 ± 0.85 (0.88–3.53)	1.75 ± 0.86 (0.84–3.29)	U = 107,* z = −2.58
Canopy cover (%)	16.07 ± 9.42 (2–50.8)	76.12 ± 28.31 (5–100)	U = 139,* z = −2.71

* $P < 0.01$, ** $P < 0.001$, *** $P < 0.005$.

0.046), angle between trunk and branches (F = 73.28; P = 0.0001), nest-tree height (F = 98.24; P = 0.0001), tree crown volume (F = 87.16; P = 0.0001), distance of nest tree from forest edge (F = 6.06; P = 0.001), distance of nest tree from timber harvesting (F = 13.84; P = 0.0001), and average trunk spacing (F = 44.62, P = 0.0001). Single linkage analysis (Sneath and Sokal 1973) did not form separate groups of nest trees on the basis of these seven variables but Ward's analysis (Everitt 1974) identified four groups of nest-site plots which enabled us to identify each nest-site variable as belonging to a group with a unique pattern of variables. Groups 1 and 3 contained 25 and five

Table 2. Average (±SD) of the seven main components (PCA) in the four groups of nest-site plots identified by the Ward's method.

VARIABLE	GROUP 1	GROUP 2	GROUP 3	GROUP 4
Elevation (m)	921.6 ± 121.5	993.1 ± 30.4	1057 ± 163.8	897.5 ± 113.74
Angle between trunk and nest branch (°)	13.8 ± 20.5	69.8 ± 10.3	6 ± 13.4	58.3 ± 5.2
Tree height (m)	1.9 ± 2.9	13.3 ± 3.2	0.7 ± 1.6	18.9 ± 3.5
Tree crown volume (m^3)	1.0 ± 2.0	56.5 ± 41.3	0.2 ± 0.5	283.6 ± 95.8
Nest distance from forest edge (m)	38.8 ± 25.4	61.9 ± 42.5	106 ± 24.1	73.3 ± 54.4
Nest distance from timber harvesting (m)	29.8 ± 18.6	43.1 ± 23.9	98 ± 24.9	37.5 ± 22.3
Trunk spacing (m)	0.4 ± 0.5	2.1 ± 0.8	0.2 ± 0.4	2.5 ± 0.7

plots, respectively, and none had nest sites. Groups 2 and 4 contained 29 and six plots, respectively, and had nine (31%) and four (66.7%) nests.

For each of the seven main components, the average in each group was determined (Table 2). Averages for groups 2 and 4 that contained nest plots were 993.1 m and 897.5 m for elevation, 69.83° and 58.33° for the angle between the trunk and the branch supporting the nest, 13.26 m and 18.91 m for nest-tree height, 56.47 m^3 and 283.58 m^3 for the tree crown volume, 61.86 m and 73.3 m for the distance of the nest tree from the nearest forest edge, 43.06 m and 37.5 m for the distance of the nest tree from the nearest timber harvesting; and 2.08 m and 2.47 m for trunk spacing.

Mean values for several variables were higher in nest-site plots than in sample plots. There was a significant difference for tree height (U = 211, z = −3.37, P = 0.0008), tree crown volume (U = 46, z = −4.04, P = 0.0002), trunk spacing (U = 107, z = −2.58, P = 0.01), nest-tree diameter (U = 340, z = −3.36, P = 0.0009), number of branches in the nest tree (U = 511, z = −3.26, P = 0.002), and canopy cover (U = 139, z = −2.71, P = 0.008) between nest-site plots and sample plots (Table 1). We also found statistically significant differences between tree diameter (U = 352, z = −5.24, P = 0.001) and tree height (U = 257, z = −47.38, P = 0.001) for nest trees and other trees inside the nest plot.

Table 3. Means (±SD) of characteristics of eight "rendezvous" sites and sample plots.

	RENDEZVOUS SITES (RANGE)	SAMPLE PLOTS (RANGE)	TEST STATISTIC
Distance from nests (m)	770.8 ± 496.8 (350–1675)	1187 ± 469 (575–2275)	U = 27, z = −1.91
Maximum % slope	49.9 ± 12.3 (40–75)	52.2 ± 18 (2.5–85.7)	U = 119, z = −0.34
Minimum % slope	20.1 ± 6 (10.3–28.6)	19.1 ± 9.7 (7.14–41.7)	U = 99, z = −1.06

Rendezvous points of common buzzards averaged 770.8 m (SD = 496) from neighboring nest sites (Table 3). Regression coefficients of independent variables derived from the multiple linear regression model were negative in terms of distance of rendezvous site plots from neighboring nest sites (r = −0.0003, P = 0.01; $\bar{x}$ = 770.8 m, SD = 496.84) and for minimum slope (r = −0.002, P = 0.13; $\bar{x}$ = 20.1 m, SD = 6.16), and positive for maximum slope (r = 0.002, P = 0.14; $\bar{x}$ = 49.9 m, SD = 12.28). The highest correlation was obtained for the distance between the rendezvous point and the nearest neighboring nest site. These data showed that the distance of rendezvous sites from neighboring nest sites was the most significant factor in the choice of these gathering points. Maximum slope may have also affected site selection.

DISCUSSION

We found that common buzzards showed a distinct tendency to select nest trees located in the mid-portion of northeastern-facing mountain slopes. They built their nests at the intersection between a tree branch and the trunk, approximately ⅔ the way up the tree. This tendency was also observed by Tubbs (1974), Rockenbauch (1975), A.C.I.N.E.R. (1979), and Hubert (1993). Easy access to nests appears to be a key factor in nest placement. Nest placement between tree branches and trunks facilitates frequent trips made by adults to and from nests with food, as well as early flights of recently fledged young (Tubbs 1974, Hubert 1993). Other factors influencing nest-site selection are the presence of large branches and abundant foliage, both of which protect the nest from predators and weather (Tubbs 1974).

The tendency to use northern slopes has also been noted by Manzi & Pellegrini (1989). These slopes may provide cooler temperatures and less sunlight in the nest themselves, and the denser tree cover on northern slopes may increase protection for nests. Placement of nests midway up northern slopes, in the tallest trees available, may also increase the accessibility of nests to both adults and fledglings saving energy and reducing food demands (Weir & Picozzi 1975). Elevated nests may also provide vantage points from which hunting areas can be more easily watched (Tubbs 1974).

Our analysis indicated there were six characteristics which best described selection of nest trees by common buzzards: the angle between the nest tree branch and trunk, the height of the nest tree, the tree crown volume, the distance of the nest from the nearest forest edge and timber harvesting area, and the average trunk spacing. Selection of taller trees, with denser canopies and larger average trunk spacing has also been noted by Hubert (1993).

The proximity of nests to timber harvesting areas and areas with forest edges suggests that nest tree selection may also be influenced by the availability of nearby foraging areas (Tubbs 1974, Picozzi & Weir 1976, Cramp and Simmons 1980, Jedrzejewski et al. 1988, Hubert 1993) and their accessibility to both adult and immature buzzards (Roche 1977 and Hubert 1993).

Common buzzards apparently use rendezvous points as social gathering areas to designate territorial boundaries of neighboring pairs (Tubbs 1974). Our analysis showed that in selecting these areas, common buzzards chose steep slopes that contribute to the formation of rising air currents and facilitate high-altitude turns at these meeting sites (Weir & Picozzi 1975).

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